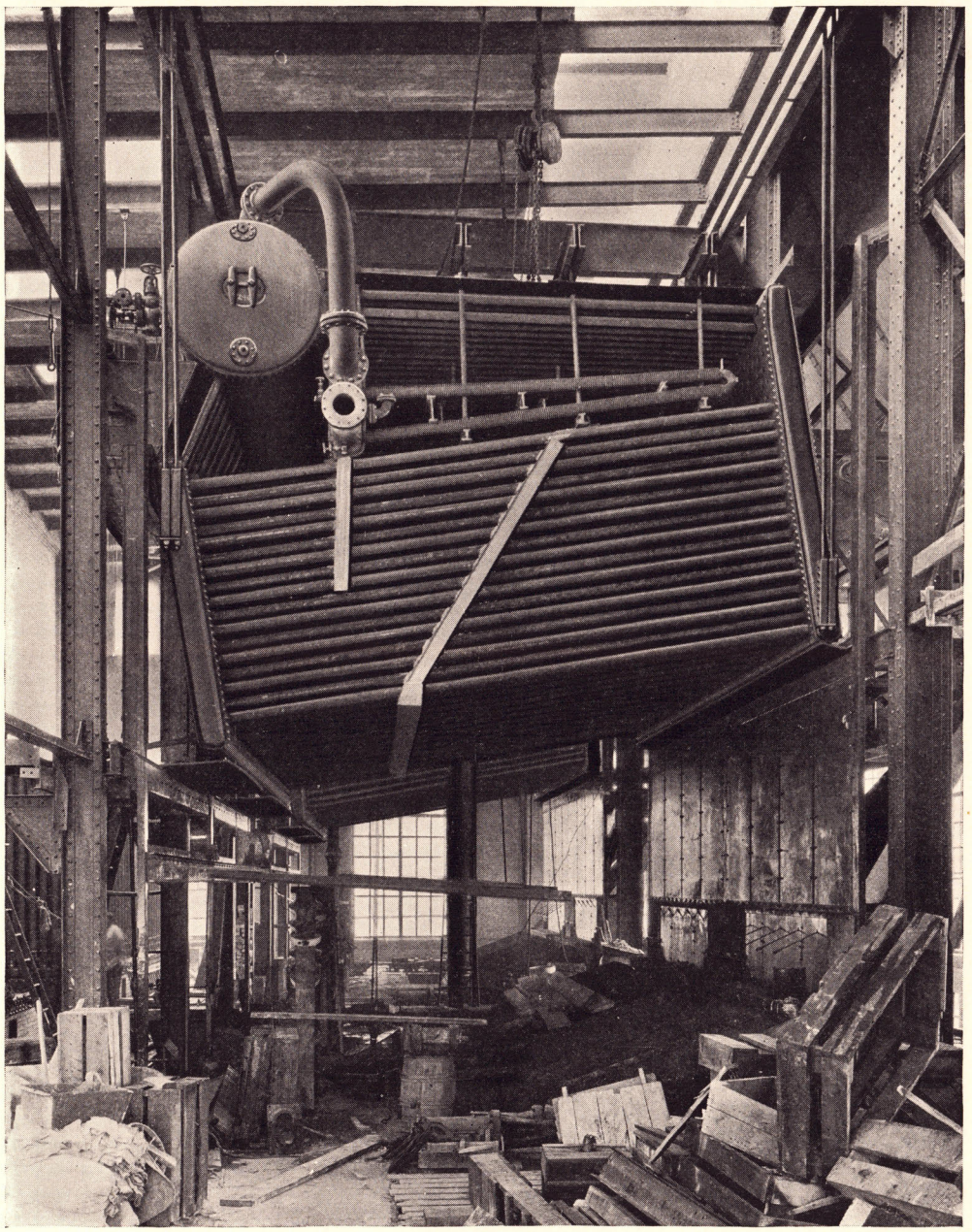
HEINE CROSS-DRUM BOILERS

M-TYPE

MC-TYPE

COMBUSTION ENGINEERING CORPORATION
NEW YORK

WM. L. HOLE



Heine MC-type 784-hp. Boiler partially erected in a large sewage treating plant. This is one of four boilers all erected at the same time.

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HEINE CROSS-DRUM BOILERS

M-TYPE *Horizontally Baffled*

MC-TYPE *Cross Baffled*

Catalog No. 53-B

COMBUSTION ENGINEERING CORPORATION

International Combustion Building

200 Madison Avenue
NEW YORK

A Subsidiary of
INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

FOREWORD

IN the forty-seven years we have been building water-tube boilers we have acquired and maintained a reputation for superior construction. By proper choice of materials and plate thicknesses and by liberal use of both labor and material on our riveted joints and connections, we greatly prolong the life of our boilers. Furthermore, in certain instances by changing tubes, our boilers have been approved, years after they were put into service, for pressures higher than they carried originally.

Our first boiler was built in 1882 and ran in continuous service for thirty-four years. Afterward it was repurchased by us and set up at our Saint Louis shop as an exhibit. It is interesting to note that a boiler insurance company has approved this boiler for operation today at the same pressure for which it was designed forty-seven years ago. This is only one of many examples of remarkable durability under service conditions, which have demonstrated the effectiveness of our methods of boiler construction.

The shops in which HEINE Boilers are built are completely equipped for production of accurate work on a manufacturing scale. Many of the operations performed in our shops are of such a special nature that we have designed, built and patented machinery for our own use. As an indication of our policy of keeping up the standards, in order to meet the constantly growing demand for boilers of higher pressure and larger size, we have recently added to our plant two additional buildings, equipped with cranes, drills, presses, and other modern machinery for heavy work, including a set of pyramid bending rolls which the makers tell us are the largest ever built.

As pioneers in the water-tube boiler field we have kept our place among the leaders in the industry by anticipating the requirements of power-plant engineers.

We have three standardized types of boilers which are built in sizes to cover the complete range of horsepower and pressure demanded by present-day practice.

Heine Long-Drum Boilers—This type of boiler when equipped with horizontal baffles is denoted as the H-type and when equipped with cross baffles, as the HC-type.

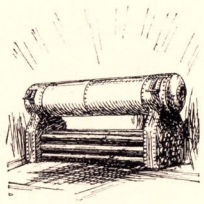
Heine Cross-Drum Boilers—This type of boiler when equipped with horizontal baffles is denoted as the M-type, and when equipped with cross baffles as the MC-type.

Heine Bent-Tube Boilers—This boiler is built in a wide range of sizes, all of which are covered by the designation V-type.

These various boilers are each described in separate bulletins, any one or all of which we shall gladly send upon request.

From the beginning, HEINE Boilers have been built to serve and we have always recognized a responsibility for the performance of our product. To serve our customers we have continually enlarged the personnel and facilities of our engineering, field service and sales departments, and today we can render the power-plant industry better service than ever before.

We are furnishing the very best designs, materials and workmanship that modern engineering skill can produce, and extend every service facility to assist our customers in maintaining the highest standards of performance.



HEINE BOILER NO. 1

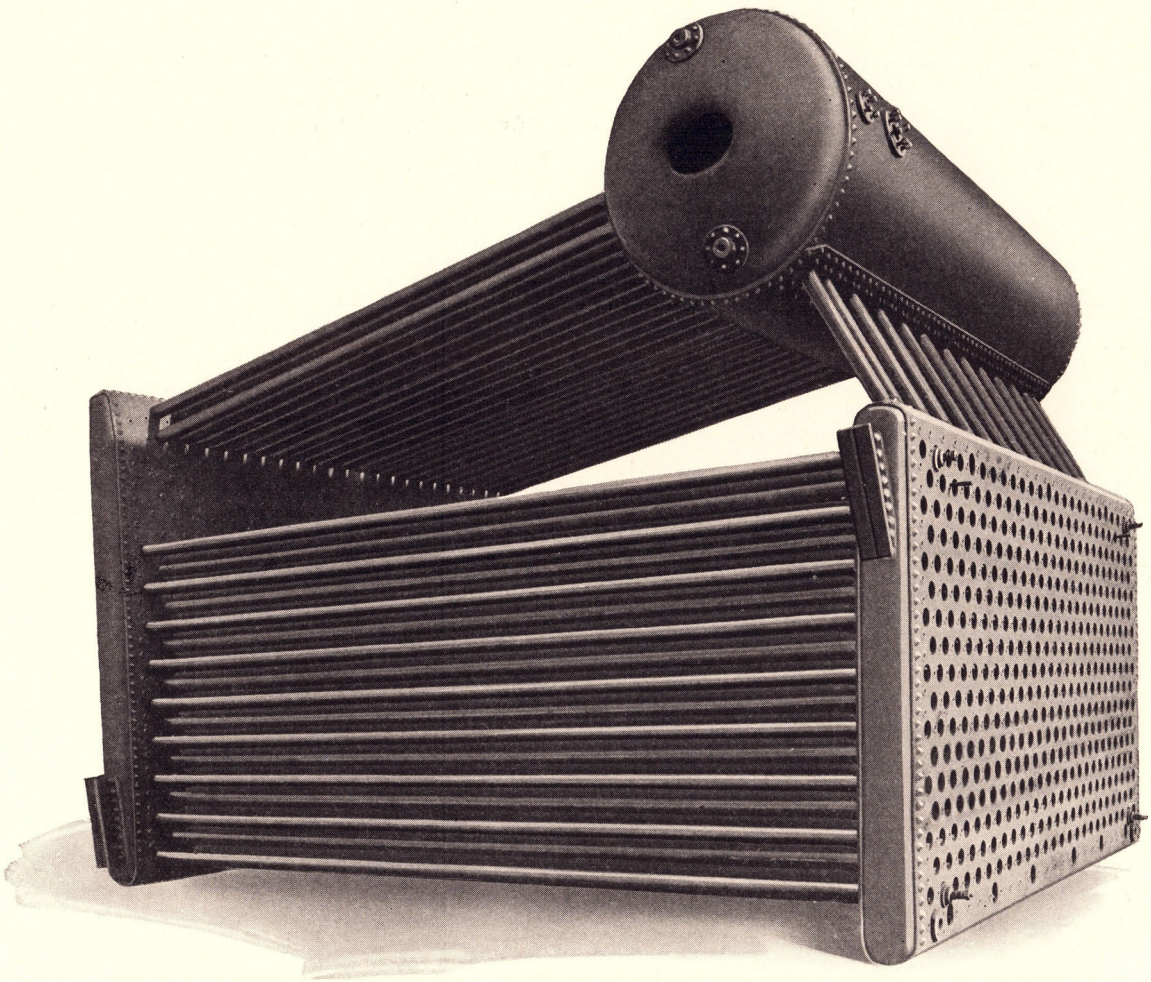


Fig. 1—Heine MC-type 784-hp. unit, designed for use with superheater above the tube bank. This particular boiler is equipped with two rows of circulating tubes; for M-types usually only one row is used.

HEINE BOILERS

M-type MC-type

PRIOR to the World War, the HEINE Boiler Company devoted all its efforts to the production of the standard HEINE Long-Drum Boilers which it had been building since 1882. There had been no thought of entering the marine field; but the loss of shipping from U-boat depredations made the need for marine boilers so imperative that the HEINE Boiler Company undertook to do what it could to supply the rapidly expanding American ship yards.

Several ships were equipped with modified designs of the standard HEINE Long-Drum Boiler. But the need for a different design, lending itself more readily to volume production, became evident shortly after the United States entered the war. The result was a cross-drum boiler that could be readily manufactured in quantities, and easily transported and assembled. Several hundred were built for the U. S. Emergency Fleet Corporation. Ninety-seven ships of Pershing's bridge of boats were equipped with HEINE Boilers. Their performance was so satisfactory that it was decided to adapt this cross-drum style of boiler to stationary practice. The design was fully worked out in all details, and the building of these boilers now constitutes a large part of the HEINE Boiler Company's business.

HEINE Cross-Drum Boilers may be arranged for the widely used horizontal baffling, or for cross baffling when so desired. The boilers with horizontal baffling are designated "HEINE M-type Boilers"; while those with cross baffling are designated "HEINE MC-type Boilers".

General Design

BOILERS of these types are made up of boxheaders connected by tubes in such a way that the tube bank contains practically the entire heating surface of the boiler. A steam and water drum extending at right angles to the tubes is located just above one of the boxheaders, to which it is connected by means of a series of short downcomer tubes or nipples, and to the other boxheader by one or two rows of longer tubes. The general arrangement is clearly shown in Fig. 1. The tube bank stands at an angle of about 10 deg. to the horizontal, the drum being at the low end, the circulating tubes connecting the drum to the opposite header being horizontal (see Figs. 15 and 16). It may be fired from either the high or low end, the latter being preferred. The exact arrangement of the baffling depends upon the furnace and other conditions.

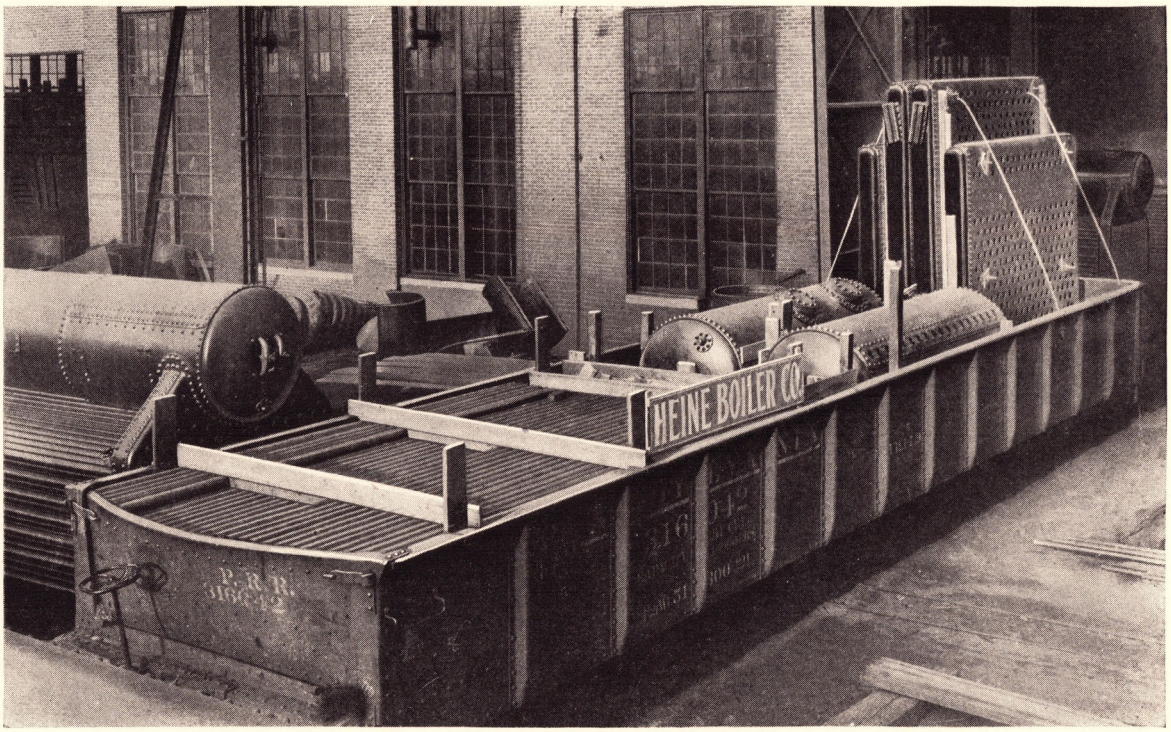


Fig. 2—Two of eight 503-hp. Heine MC-type Boilers ready to start on their journey to a large oil refinery.

Details of Construction

ALL HEINE Cross-Drum Boilers have boxheaders, made up of two heavy steel plates with long-radius turned flanges at top and bottom. The edges of the inside or tube sheets overlap the edges of the outside or handhole sheets. These sheets are riveted together with the calking-edge facing outward with reference to the boiler setting. The unflanged ends are closed by means of trough-shaped one-piece end plates, shaped accurately to fit the openings, and riveted to the header plates. Substantial lugs are riveted to each of these end plates, and the boiler supports are connected to these lugs, which are of ample dimensions to carry the weight of the boiler and contents.

The header plates, being flat surfaces, are stayed against internal pressure by means of heavy hollow staybolts screwed into accurately threaded holes, the projecting ends being riveted over to give additional holding power and tightness. These staybolts are made from heavy-wall seamless tubing which is exceedingly ductile and tough, and with a tensile strength greater than is actually required to carry the stresses to which they are subjected. The hollow feature makes it possible to use a special patented upsetting tool of our own design, which sets the metal of the bolt solidly against the plate besides giving an exceedingly neat and workmanlike finish. They are utilized also as a means of access to the gas passages for the purpose of keeping the heating surfaces free from accumulations of soot and dust. Portions of the top flanges of the tube sheets in both front and rear headers are flattened providing space for holes for the nipples and horizontal circulating tubes. These boilers are easily and quickly erected in the field since there is never anything more than the simple rolling of tube ends to be done. (See Fig. 2.)

One or more openings for drain connections are provided at the bottom of the lower boxheader.

The drum may be 42 in., 48 in. or 54 in. in diameter, depending upon the size of the boiler. The longitudinal seams are of double-strap butt-joint construction and

the holes for the circulating tubes and nipples are reinforced by means of properly riveted doubling-plates. The heads are dished to a radius equal to the diameter of the shell, therefore they require no internal staying, and they are of sufficient thickness to obviate all danger of cracking due to breathing under pressure. In all cases one head is provided with a manhole closed by means of a pressed-steel cover. In the case of larger sizes set singly, both heads are so equipped, for convenient accessibility. The drum carries the steam outlet and safety valve saddles, which are of heavy forged steel, with flanges large enough for a double row of rivets. This is shown in Fig. 3. To the drum are also attached steel pads for the feed, blowoff and water-column connections.

As to material, workmanship, dimensions and details of design, suffice it to say that they are in all as good or better than the A. S. M. E. Boiler Construction Code requirements. For example: nothing but firebox quality of plate is used throughout, although the Code permits flange quality in many places; and the thickness of the drum heads is greater than the rules require.

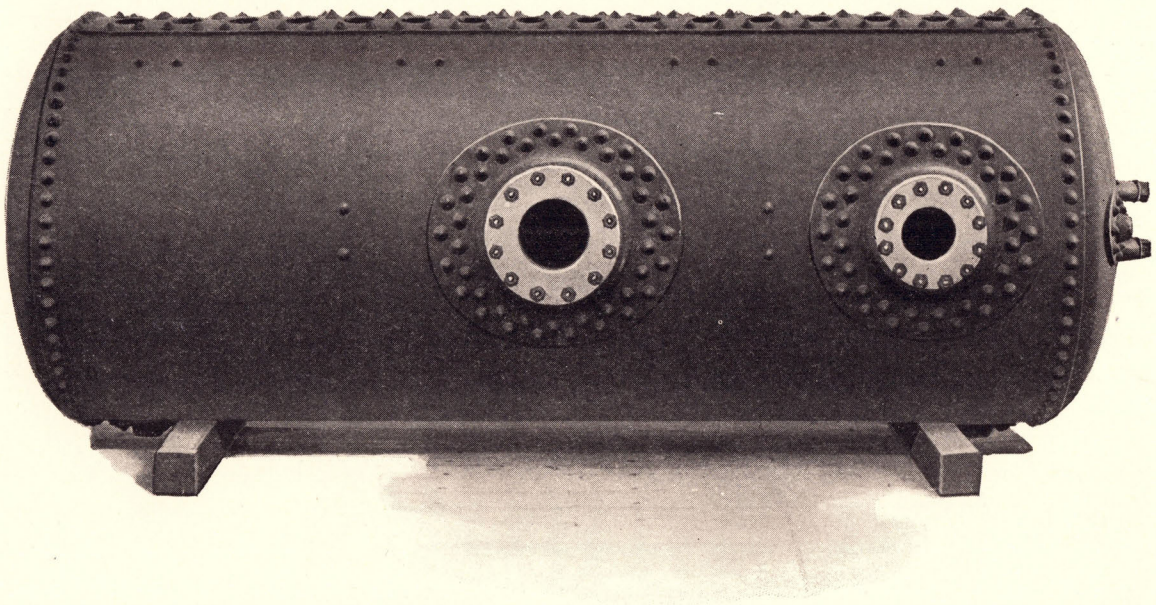


Fig. 3—The nozzle or saddle connections on all Heine Cross-Drum Boilers are of forged steel made large enough to take a double row of rivets.

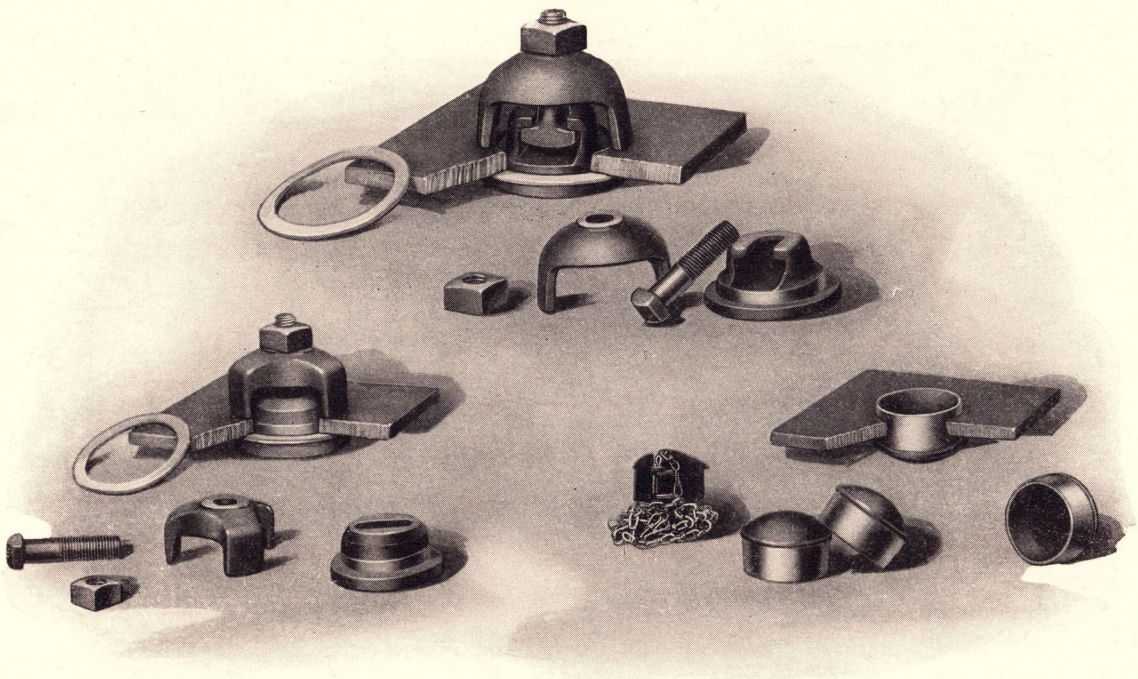


Fig. 4—The handhole closures for the openings in the boxheaders opposite the tube ends may be of cast iron or forged steel with gaskets, or of the Key type which uses no gaskets. They are arranged from left to right in the order mentioned.

Several different forms of handhole closures are used, all being of such a nature that the pressure tends to tighten them. The most generally acceptable one is a cast-iron or forged-steel plate with nut, bolt and yoke on the outside, the joint being made by means of a gasket. The Key handhole cap may also be used, this being a device that requires no gasket. The three types are shown in Fig. 4.

The boiler is usually supported by means of structural-steel columns bolted or riveted to the lugs on the end plates of the lower boxheader and by similar columns carrying suspender bars attached to the corresponding lugs on the end plates of the upper boxheader. The steam and water drum is supported entirely by the circulating nipples and tubes. A deflection plate is fitted inside of the drum in contact with the shell just above the circulating tubes and extending below the water level, open at each end, and of such a length as to leave open spaces between the ends of the plate and the two drumheads.

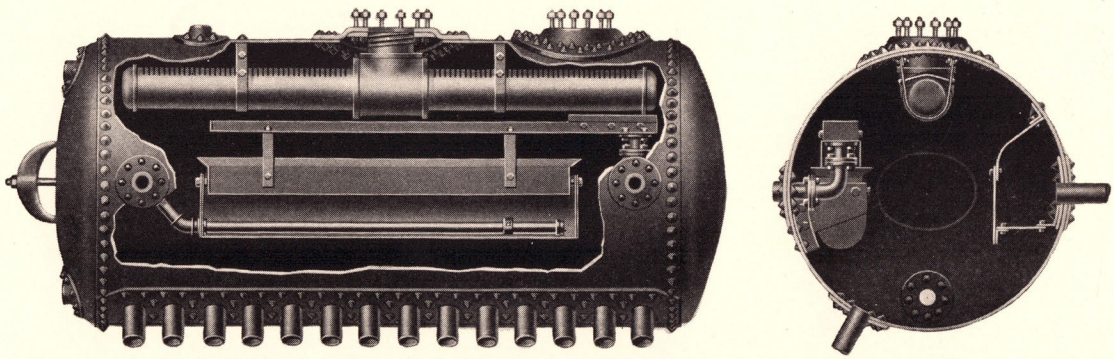


Fig. 5—All Heine Cross-Drum Boilers are equipped with a special patented device for purifying and heating the feed water. This device together with the drypipe and the deflection plate assures dry steam and a stable water level.

A drypipe with slots in the upper side extends nearly the entire length of the drum, close to the upper part and attached to the steam outlet by a threaded connection; the ends of the dry pipe are capped. Along the front part of the inside of the drum is located a feed pan of special patented design arranged as shown in Fig. 5. The water column connections are attached to one head of the drum. The column itself being located in a position best suited to the layout of the plant.

A properly stiffened steel-plate upper front, with necessary cross braces is supplied with casing doors giving access to the boxheaders. For hand firing a lower front with the usual fire and ash pit doors, dead plates, jambs and arches, grates and bearing bars suffices, but for stoker firing all fire front is omitted to a point ordinarily 6 ft. above the floor line, thus providing for the application of any type of furnace. The steel plate upper and lower hand-fired type fire front are shown in Fig. 6.

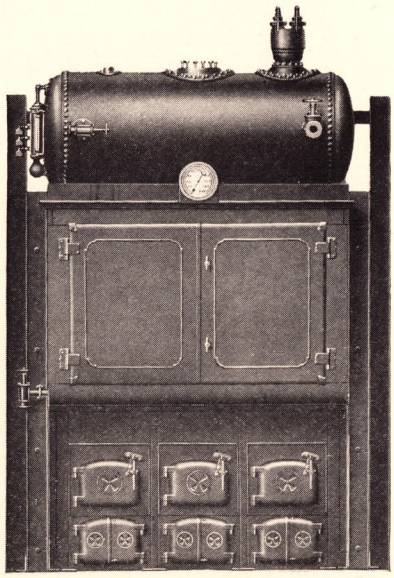


Fig. 6—All Heine Cross-Drum Boilers are provided with steel-plate upper fronts and where hand firing is used they are also provided with lower fronts containing the usual fire and ash doors. Both upper and lower fronts are shown in this illustration.

Boilers may be set so as to give any desired height of furnace and may be fired from either the high or low end, but much better furnace and combustion conditions are obtained by firing from the low end. When erected ready for service the boilers are enclosed in whatever kind of setting may be preferred, this usually being the ordinary refractory-lined brick-work which extends in height to the level of the horizontal circulating tubes. A sheet-iron roof plate over the circulating tubes carries a brick and nonconducting covering. This roof plate tightly adjoins the drum and the uptake frame which is ordinarily a narrow rectangular opening extending the full width of the tube bank and is made of structural shapes so arranged as to provide for the easy attachment of the breeching.

The foregoing description applies to either the horizontally baffled M-type boilers or the cross baffled MC-type boilers. The only difference in construction between the two types is that in the former the tubes are nested more closely together than in the latter.

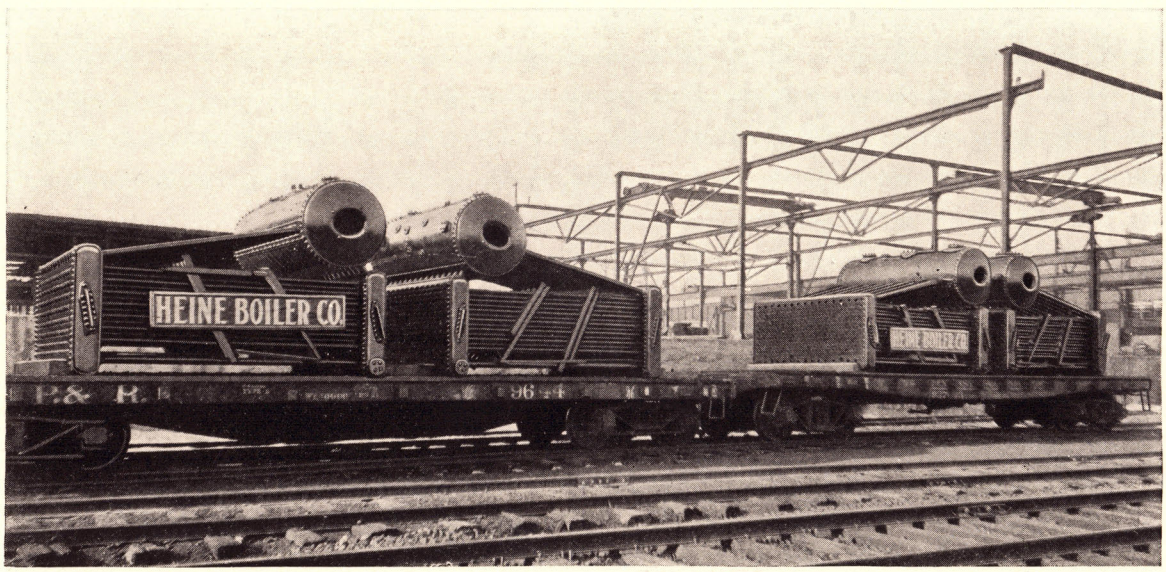


Fig. 7—Four of an order of twelve Heine MC-type Boilers ready for shipment.

Circulation

THE normal water line is 3 in. below the center of the drum so that the tubes and boxheaders are filled with water with the exception of the extreme top of the higher header and the horizontal circulating tubes. The feed water is introduced into the boiler through the feed connection which supplies a special water-purifying device shown in Fig. 5. This device not only deposits suspended and precipitated solids, but it also brings the temperature of the feed-water up to that of the steam, and distributes it uniformly along the length of the drum.

The water descends through the circulating nipples into the lower boxheader, thence through the bank of tubes where the steam is formed, the mixture of water and steam rises into the higher boxheader where it is carried to the drum through the horizontal circulating tubes. The difference in weight of the front and back columns tends naturally to raise the water line at the rear so that even though the normal water line in the drum is slightly below the circulating tubes the return water finds no difficulty in entering these for the journey back to the shell. The mixture of steam and water issuing from the tubes into the drum strikes the deflection plate, the water being thrown down, the steam continuing on into the steam outlet.

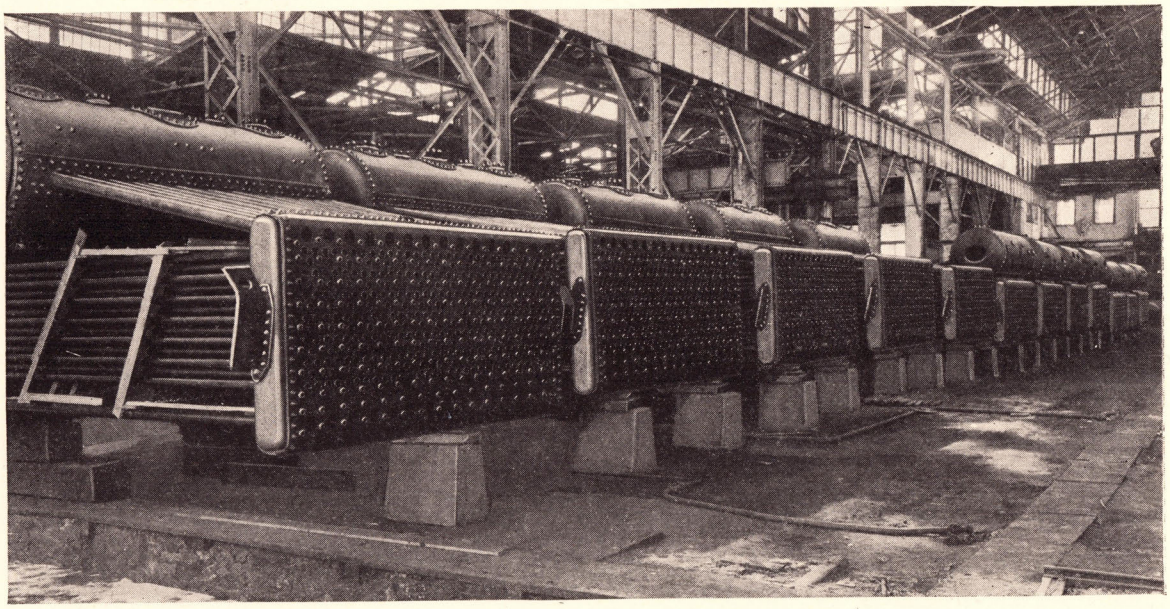


Fig. 8—Line of Heine MC-type Marine Boilers in the shop ready for shipment.

Furnace Arrangement

AS heretofore stated HEINE Cross-Drum Boilers may be fired from either the high or low end, although the latter is much the preferable method. This brings the drum at the front of the boiler which is more convenient than to have it at the rear. Firing from the high end is usually resorted to only in those cases where a lack of head room makes it necessary. The discussion of furnace and combustion conditions will be divided in two parts, (a) pertaining to the M-type boiler, (b) to the MC-type boiler, and will be on the basis of being fired from the lower-header end. Any type of grate or stoker may be applied to these boilers and they may be adapted to the use of waste heat, powdered-fuel, oil, gas or any other fuel. The description of the operation for coal-burning only will be attempted, but the principles involved are exactly the same for other fuels.

(a) HEINE *M-type Boilers* are provided with horizontal baffles. These may be arranged in a great variety of ways, and care is always taken to proportion the areas of the gas-passages to the kind of fuel to be used, the probable capacity at which the boiler will be run, draft available, etc.

For low capacity and hand firing with natural draft in the smaller sizes, the single-pass arrangement is ordinarily used. (See Fig. 15). This consists of one baffle on the lower, second, or third row of tubes as may be desired, with an opening at the back and another baffle on the top row of tubes with the opening at the front. In large sizes with high capacity furnaces a middle baffle somewhat more than half way up the tube bank is introduced giving double pass of the gases through the tube bank. When arranged for a middle baffle, a row of 5 in. stay-tubes is introduced in both the front and rear boxheaders through which the baffle tile may be introduced and adjusted. This three-baffle arrangement is shown in Fig. 16. The most usual arrangement for the lower baffle is on the third row of tubes with the opening at the back. However, the baffles are easily changed to suit changing conditions. The method of arrangement is shown in Fig. 17. This exposes the entire length of the three lower rows of tubes so that the maximum absorption of radiant heat may be obtained,

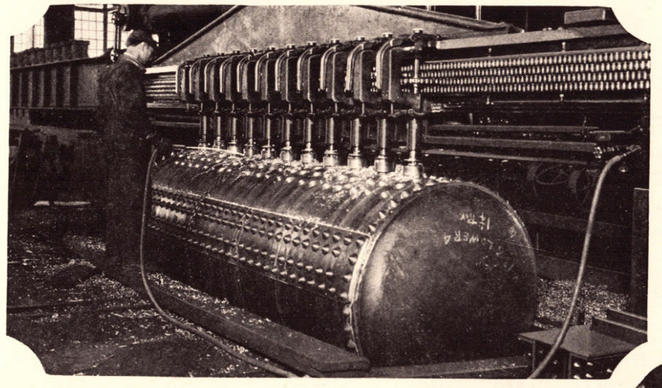


Fig. 9—The tube holes in all Heine Boilers are bored by machine, which assures accurate diameter and true location of every hole.

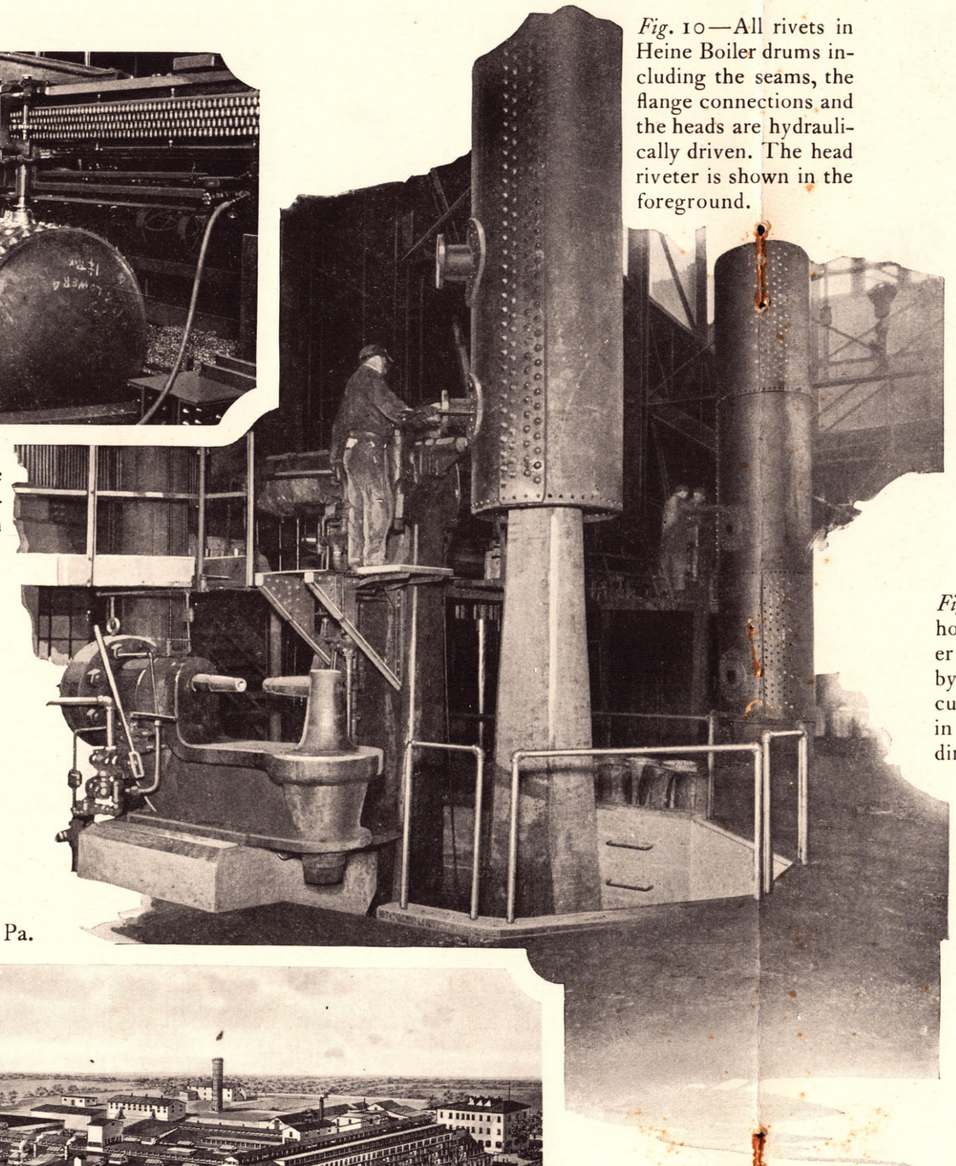


Fig. 10—All rivets in Heine Boiler drums including the seams, the flange connections and the heads are hydraulically driven. The head riveter is shown in the foreground.

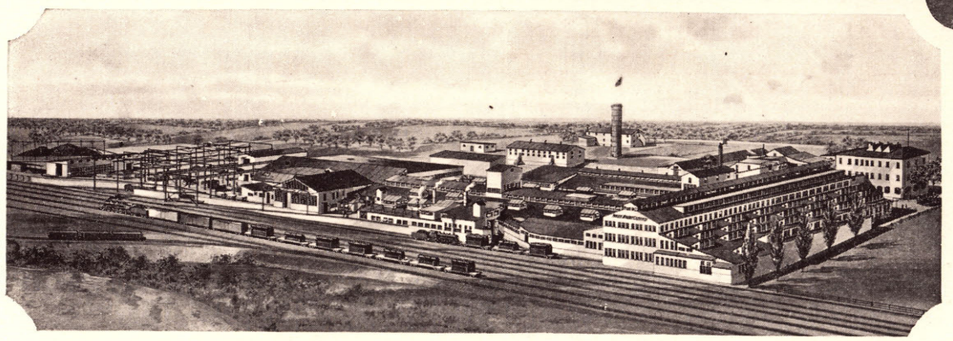


Fig. 11—Plant No. 2, Phoenixville, Pa.

Fig. 12—Plant No. 1, St. Louis, Mo.

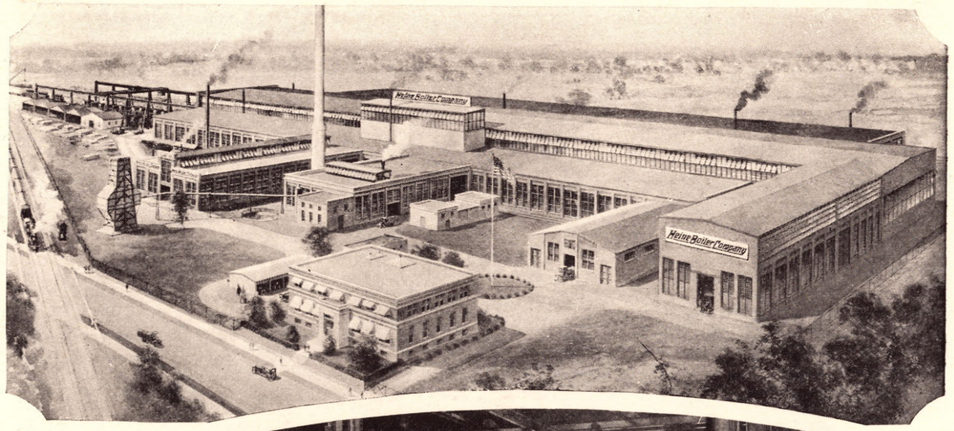
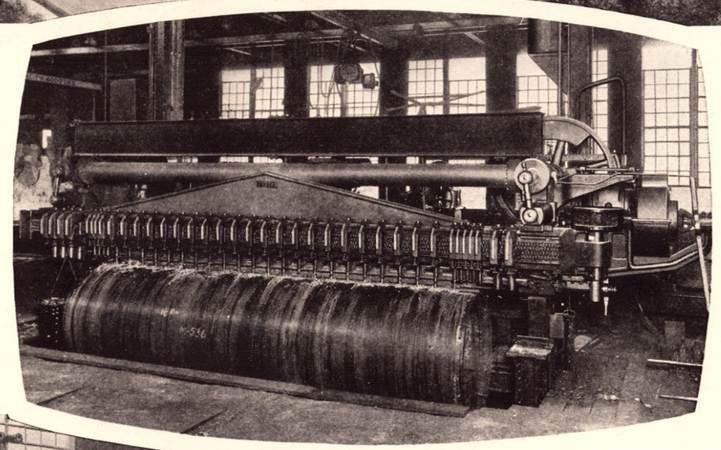


Fig. 13—All rivet holes in Heine Boiler drums are drilled by machine to accurate diameter, and in true location and direction.



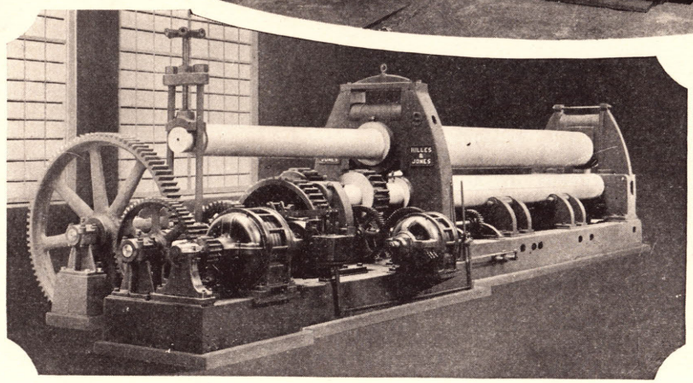


Fig. 14 — This set of pyramid rolls—largest ever built — permits Heine Boilers to be constructed in sizes and plate thicknesses called for by the most recent demands for high pressure and large capacity.

Heine Boilers are manufactured in the two modern boiler plants illustrated above, one of which is located in St. Louis, Mo., and the other in Phoenixville, Pa. These shops are equipped with special machinery, much of which was designed by Heine engineers, to insure accurate workmanship on a manufacturing scale.

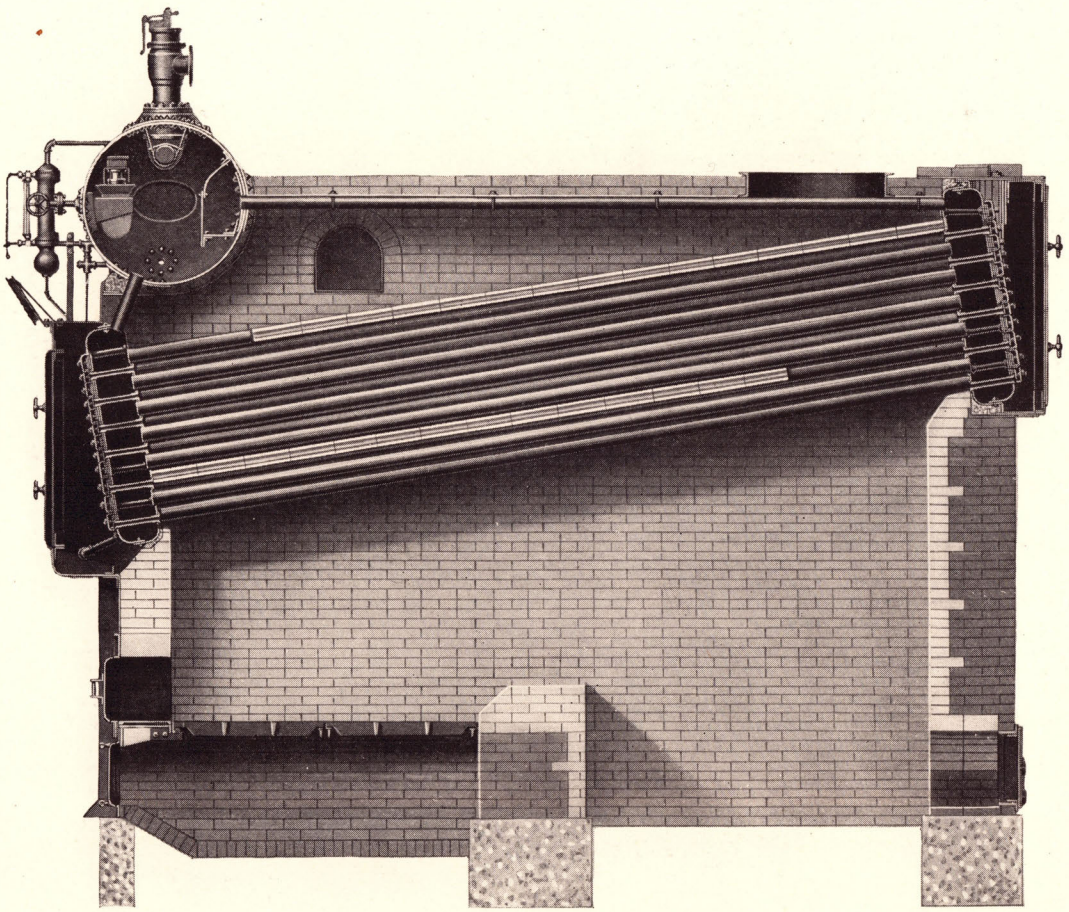


Fig. 15—Typical single-pass Heine M-type Boiler arranged for hand firing.

while at the same time some absorption of heat results from the actual contact of hot gases. The upward slope of the tubes to the back provides a combustion chamber of increasing volume from the front to back, thus giving ample room for continual burning of the gases rising from the grates. A bridge wall suited to the type of grate or furnace used is always provided.

The gases of combustion then pass into the tube bank through the opening back of the lower baffle and come forward parallel to the tubes. Where a middle baffle is

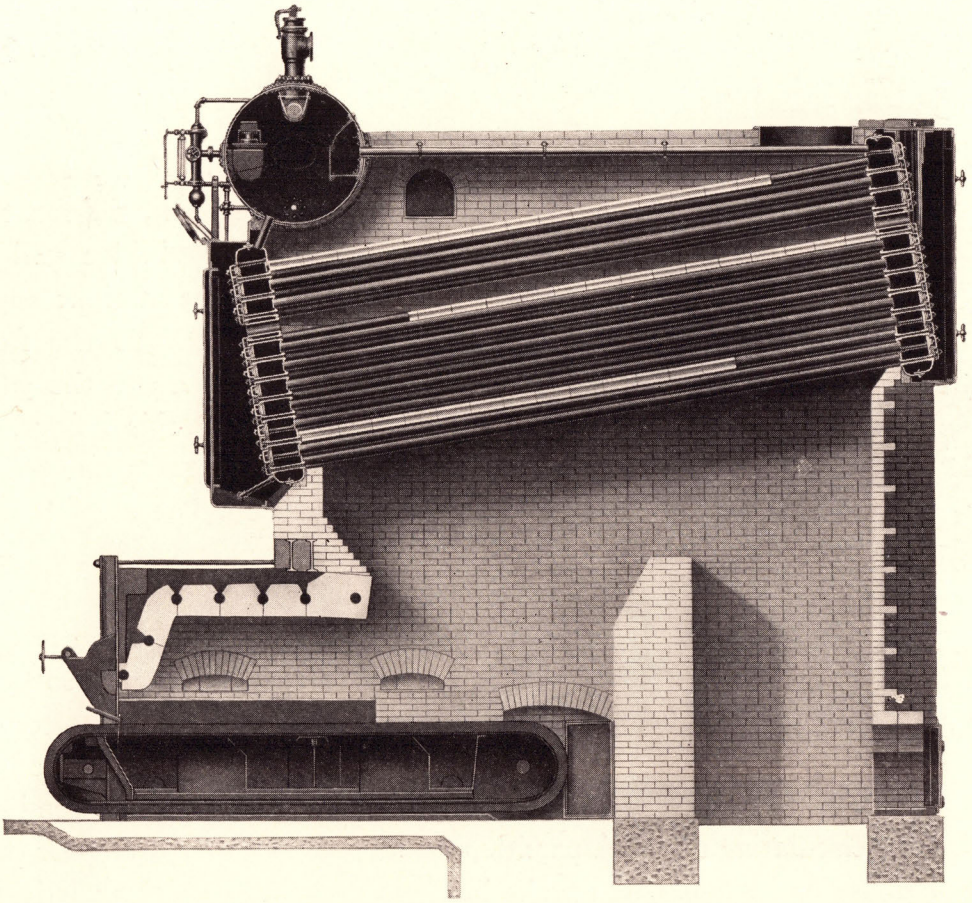


Fig. 16—Typical two-pass Heine M-type Boiler arranged for chain grate stoker and high bridge wall.

used they turn up through the opening in front of this, thence backward along the tubes to the opening at the rear of the top baffle. The uptake may be located at any point between the drum and the rear box-header, so that the gases after leaving the main tube bank are in contact with the horizontal circulating tubes, thus tending to generate more steam, and superheat that which is already made, and turn up between these tubes into the breeching. The uptake located just above the top of the boilers should be provided with a damper by which to regulate the fire.

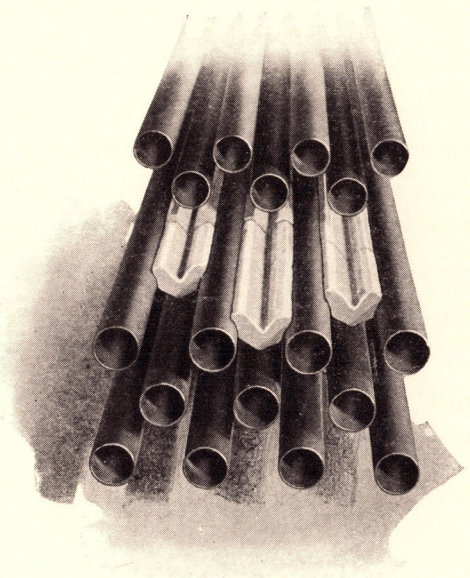


Fig. 17—Heine M-type Boilers are designed to use patented B-type baffle tile. These are of such size and shape that they can be removed or replaced at any time without disturbing the tubes or dismantling the boiler.

(b) HEINE *MC-type Boilers* are provided with cross baffles which may also be arranged in various ways. Heretofore the most generally used plan has been to have the bridge wall extend up to the tube bank, the front baffle rising from just above the bridge wall to the upper tubes. This may be at right angles to the tubes or inclined towards the front so as to give a decreasing area to the gas passage as shown in Fig. 18, this being proportioned to the decrease in gas temperature due to the heat absorption. The second baffle is located nearer the back end of the boiler than it is to the front baffle, and with the arrangement under consideration, ordinarily extends the full height of the tube bank so that the gases after passing through the second pass turn entirely beneath the tubes and rise into the third pass, and thence into the space beneath the horizontal circulating tubes. A partition baffle extends from the boiler deck to the top of the second baffle. The uptake being located between this partition and the shell, the gases on leaving the tube bank rise between the circulating tubes into the uptake. There is thus provided opportunity for slightly superheating the steam that is already made and the formation of a little more steam in these tubes. The uptake should be provided with a damper above the circulating tubes for the proper control of the fire.

Another and preferable arrangement of the furnace is to use a low bridge wall and make use of the entire combustion chamber as in the case of the M-type boiler. (See Figs. 19 and 20). With this arrangement a horizontal baffle is placed on the bottom, second, third, or higher row of tubes, extending approximately half way or a little more of the length, from which point the cross baffle starts and reaches to the top of the tube bank. The second and third passes are thus located at the front end,

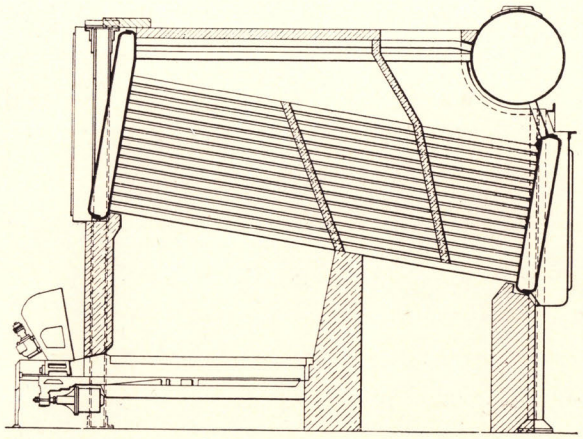


Fig. 18—Heine MC-type Boiler arranged with high bridge wall and second baffle so placed as to force all gases clear below the tube bank.

the first pass being at the back. This arrangement exposes the entire lower rows of tubes to radiant heat besides being in contact with some proportion of the hot gases. The gases rise in the first pass turning forward and downward into the second pass, under the short cross baffle, thence upward into the space beneath the horizontal circulating tubes into the uptake located just back of the drum as in the previous arrangement. A modification of this plan is to bring the gases out under the drum and between the circulating nipples into the breeching. (See frontispiece).

Cross baffling may be further modified by supplying three baffles, thus making four passes for the gases, the outlet being below and at the rear.

In order to maintain maximum efficiency the baffles must be located to fit the operating conditions and it is important that there be no leakages around the tubes from one pass to another. The baffles should be of such a nature as to maintain these conditions under stress of all kinds of service, and to this end our Research Department has developed a mixture known as REFRACTITE. This is shipped in dry form, and prepared by mixing with water to semi-fluid state, and then introduced into place between forms. It sets so as to be self-sustaining in about 24 hours and is a true refractory at all temperatures to which it may be subjected. The shrinkage is inappreciable so that no openings for by-passing of gases ever occur. Special means are provided for preventing adhesion of the REFRACTITE to the tubes, thus making it possible to remove a tube should it become necessary, without damaging the baffle itself. Elaborate experiments and trials have demonstrated that this material is excellent for the purpose intended. (See Fig. 22).

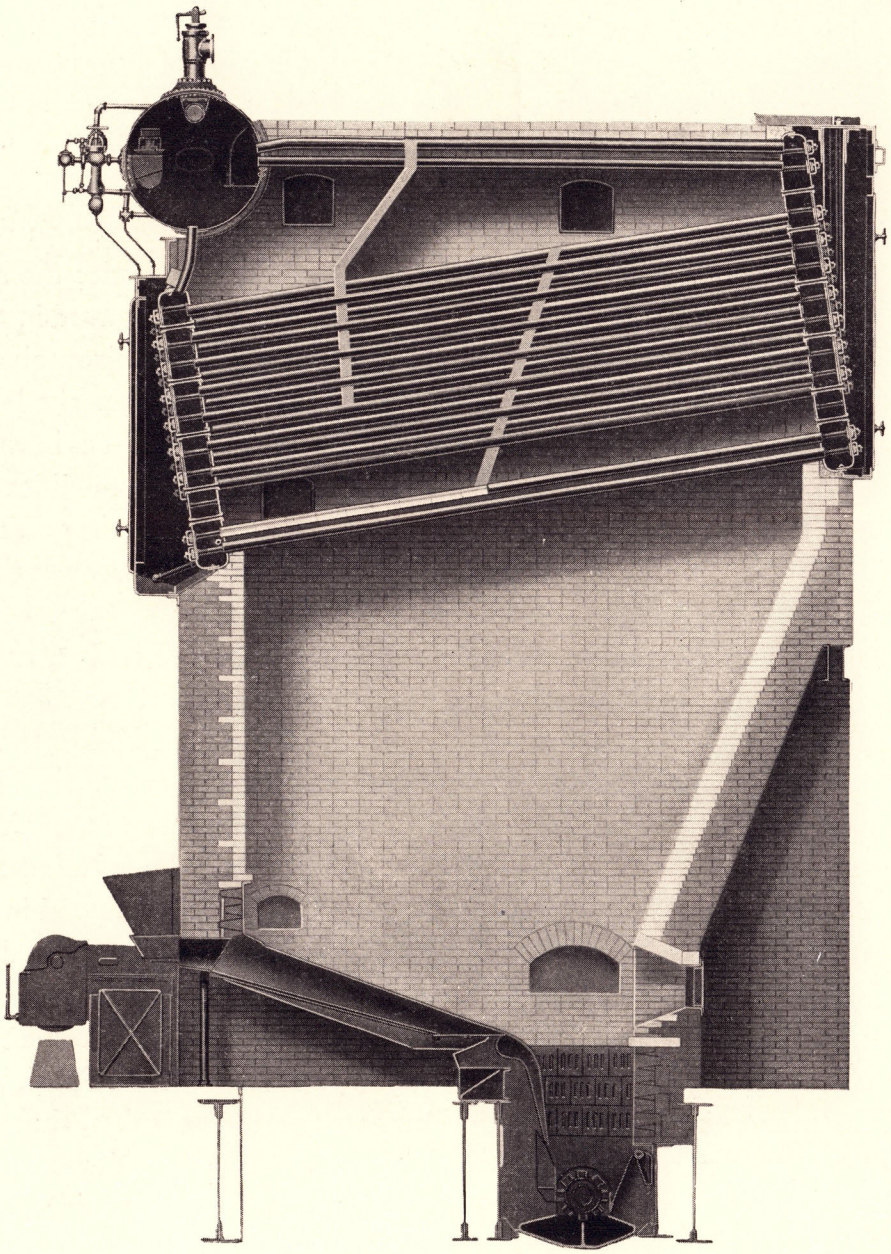


Fig. 19—Heine MC-type Boiler arranged with combination of horizontal and cross baffles.

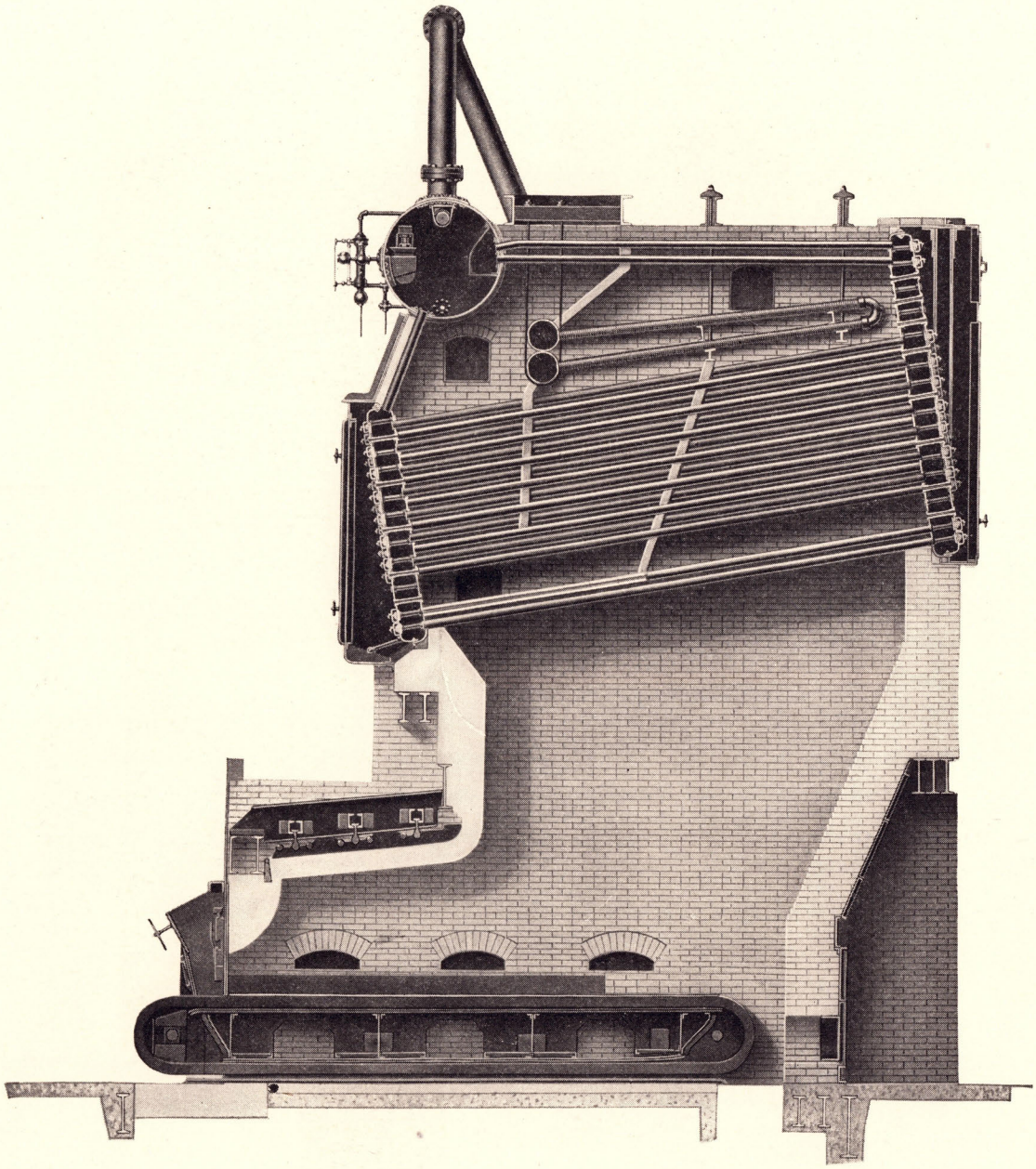


Fig. 20—Heine MC-type Boiler with combination horizontal and cross baffling, equipped with superheater above the tube bank.

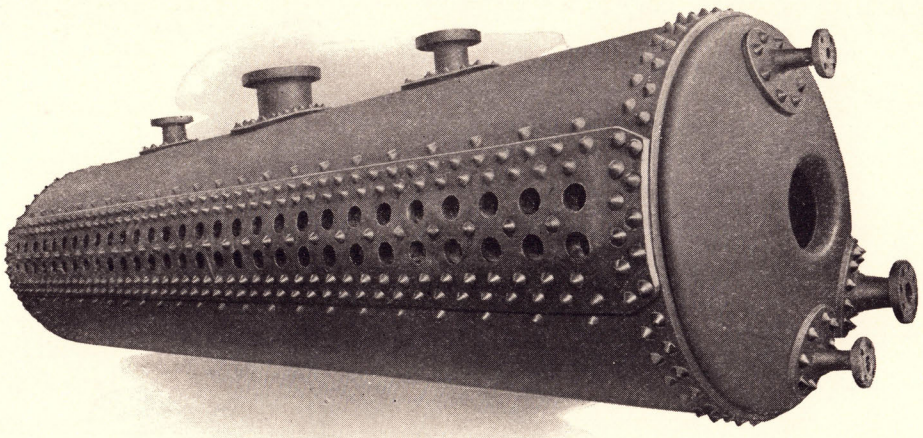


Fig. 21—Steam and water drum of a 1044-hp. 440-lb. per sq. in. pressure MC-type Boiler. Note the doubling plate along the tube holes and the double riveting in heads.

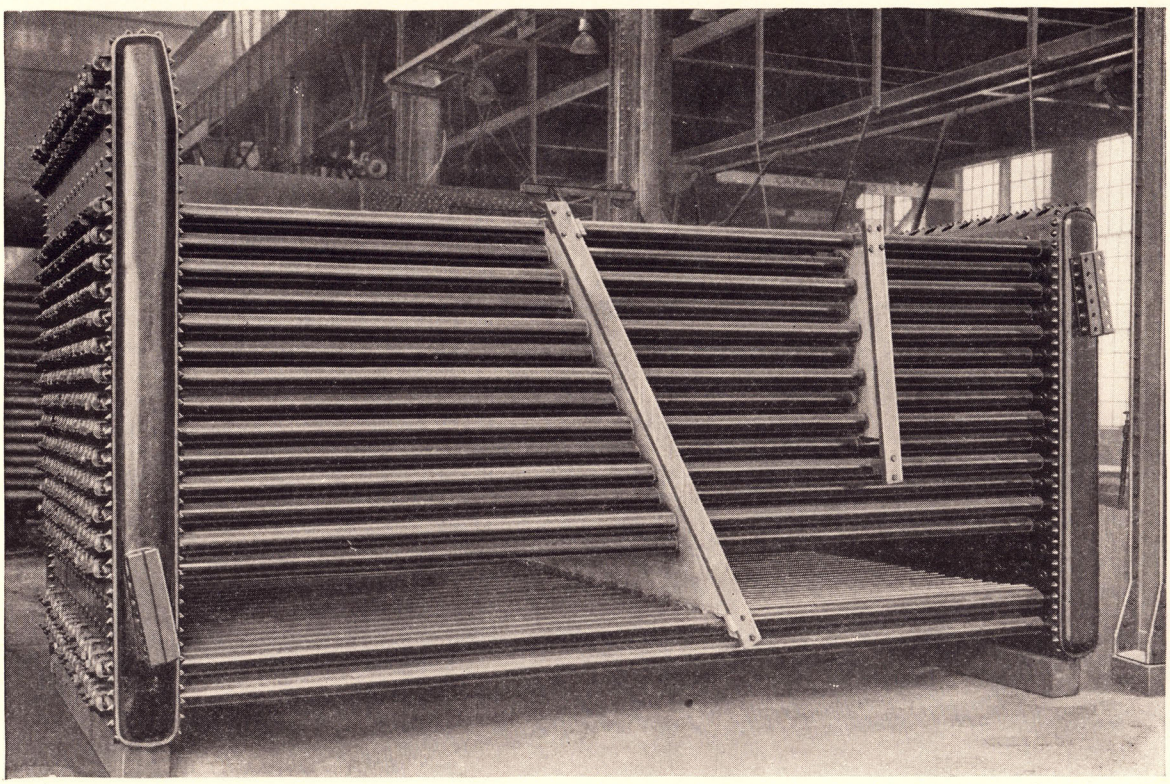


Fig. 22—The Heine Research Department has developed a refractory material for monolithic baffles which it denotes as REFRACTITE. This MC-boiler with the drum detached is ready for shipment with REFRACTITE baffles in place.

Cleaning Boilers

ALL HEINE Cross-Drum boilers can be cleaned internally with a minimum expenditure of time and energy since each tube is accessible through its corresponding handhole, so that it may be inspected and cleaned from the outside of the boiler at either end whichever is more convenient. The manhole gives access to the interior of the drum for inspection of, and attention to, the several internal appliances. There is no part of the inside of the boiler which cannot be thoroughly inspected by direct vision and reached with tools for properly cleaning the various surfaces.

All M-type boilers may be provided with a steam soot-blowing system which is applied to the hollow staybolts. This system enables the external surfaces to be cleaned of accumulations of soot and dust by merely opening a series of valves at stated intervals. No openings are needed in the side walls for any cleaning operations.

In MC-type boilers, the front and rear passes may be cleaned by means of a steam hand lance through the hollow staybolts, the middle pass being cleaned from the side by a hand lance introduced between the rows of tubes through openings in the side wall provided for this purpose and the front and rear passes may also be cleaned in this way if desired. Any of the well-known rotating steam jet blowers may be installed in these boilers.

It will thus be seen that both HEINE M-type or HEINE MC-type boilers may be thoroughly, satisfactorily and easily cleaned both internally and externally, thus enabling them to be kept in the most efficient condition for economical operation, with a minimum expenditure of time and labor.

Sizes and Pressures

BOILERS of the M and MC-types can be built in units of from 100 hp. to 1500 hp. and for pressures up to 450-lb. per sq. in.

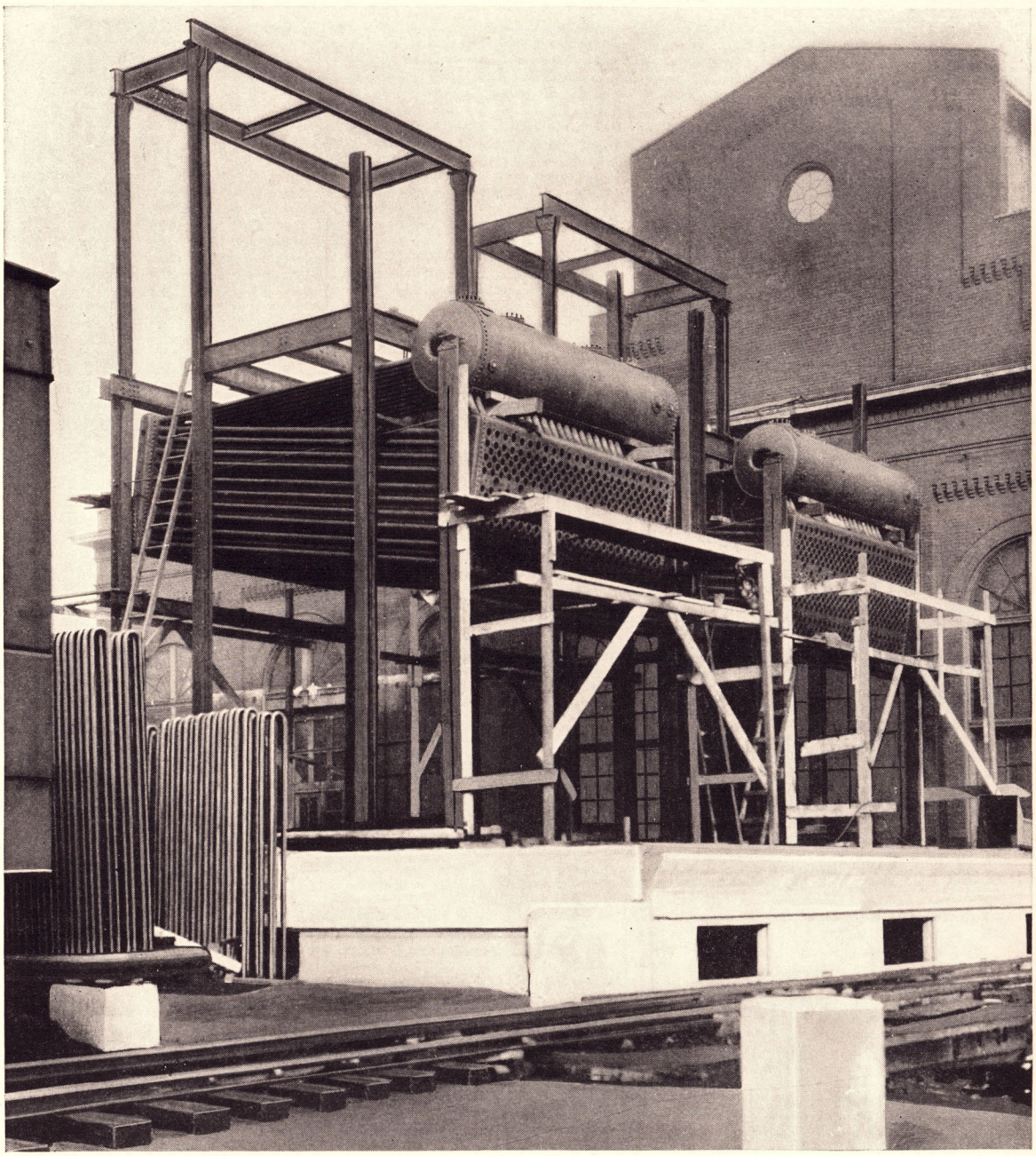


Fig. 23—Heine M-type 770-hp. Boilers in process of erection as an addition to a large electric power plant. The spaces in the tube banks for the horizontal baffles are plainly visible.

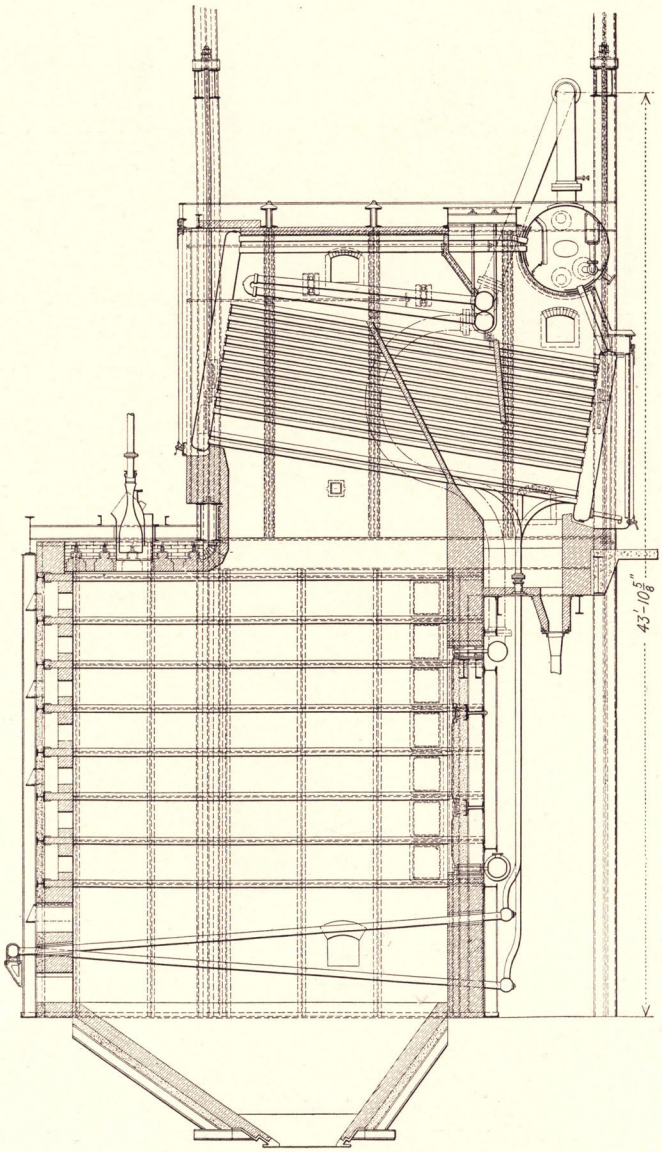


Fig. 24—Heine MC-type 1044-hp. Boiler built for 325-lb. per sq. in. pressure and arranged for burning powdered coal. This is one of three installed in an electric power station. Note the accessibility of water screen connections and piping.

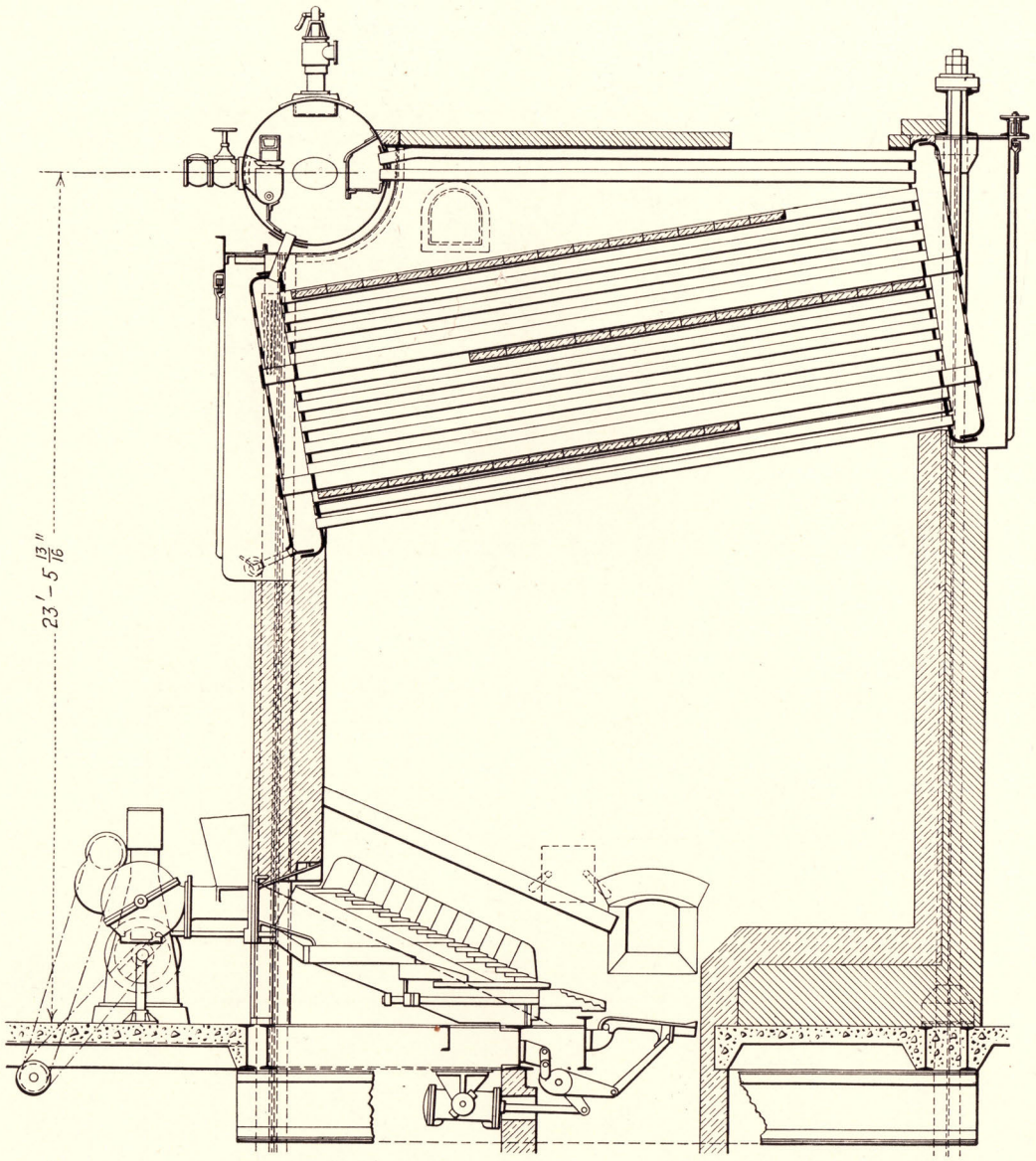


Fig. 25—Heine M-type 1000-hp. Boiler equipped with three baffles. This is one of 17 boilers of this type installed in the plants of a large builder of automobile bodies.

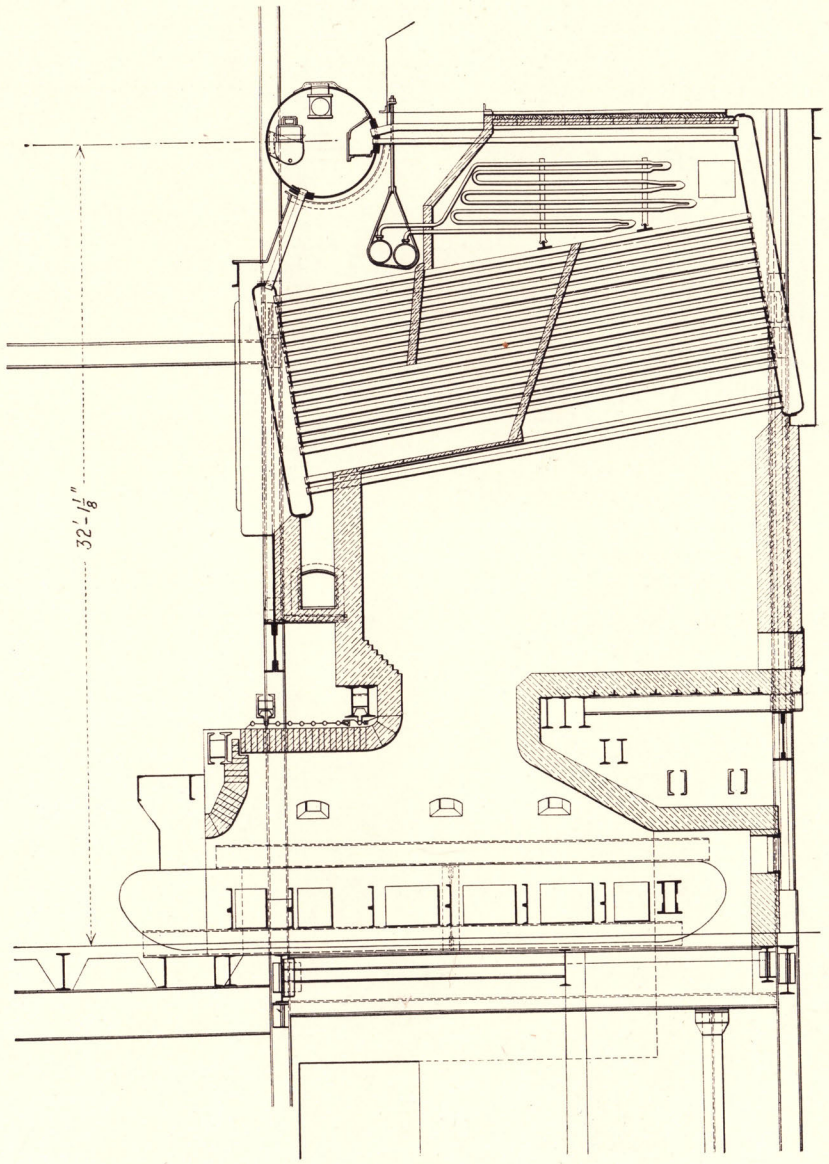


Fig. 26—Heine MC-type 1200-hp. Boiler, one of two installed in an electric power station. They are arranged with combination of horizontal and cross baffles and equipped with superheater above the tube bank.

Products of Combustion Engineering Corporation

FROM the small hand-fired plants to the largest power stations in the world, there are C-E products properly suited to the fuel burning and steam generating problems involved. Combustion Engineering installations range from small stoker and boiler units developing less than 100 hp. to the largest steam generating units in the world capable of evaporating over 800,000 lb. of steam per hour.

C-E equipment includes seven types of mechanical stokers, both storage and direct-fired pulverized fuel systems and every type of steam boiler. In addition to fuel burning and steam generating equipment, this organization designs, manufactures and installs water-cooled furnaces, air-preheaters, economizers, ash conveyors and industrial furnace equipment.

By reason of the diversity of these products and the experience gained in their development and application, Combustion Engineering Corporation is in a position to analyze any fuel burning or steam generating problem and to suggest the equipment which offers the best technical and practical solution. This is a unique service, and it is an assurance to those who use C-E products that the equipment furnished will provide the most economical steam production possible with the existing plant and fuel conditions.

A complete list of C-E products follows:

Lopulco Storage System
(*pulverized fuel*)

Lopulco Unit System
(*pulverized fuel*)

Lopulco Water Screen

Raymond Pulverizing Mills

Simplex Unit Pulverizers

C-E Fin Furnace
(*water-cooled*)

C-E Air Preheater

C-E Economizer

Coxe Traveling Grate Stoker
(*forced draft*)

Green Chain Grate Stoker
(*forced draft*)

Green Chain Grate Stoker
(*natural draft*)

C-E Underfeed Stoker
(*multiple retort*)

Type E Underfeed Stoker
(*center retort*)

Type K Underfeed Stoker
(*small boilers*)

Type H Underfeed Stoker
(*industrial furnaces*)

Special Furnaces
(*for oil, gas or solid fuels*)

Quinn Oil Burners

C-E Ash Conveyor
(*water sealed*)

C-E Ash Hopper

Combustion Steam Generators

Combustion Engineering Boilers
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(*Ladd Type*)
(*Walsh-Weidner Type*)

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(*Lopulco Systems for Industrial Furnaces*)

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Chattanooga, Tenn.
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Johnston Building

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Hazleton, Pa.
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Plymouth Building

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